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(54) METHOD FOR OBTAINING HOLLOW FORGINGS BY RADIAL FORGING OF CONTINUOUS BLANKS.

(57) A method for obtaining hollow forgings by radial forging of continuous blanks, where the generatrix AA of the surface of the edge of the continuous blank (1) is oriented along the longitudinal axis CC of the working surface of the pressing block head, is swaged in a radial direction by means of at least one pair of the pressing block heads (3) first in one direction with its subsequent rotation along its longitudinal axis OO and/or movement in the axial direction OO, is swaged in another radial direction at a deformation degree within 3-8 % of the current cross-sectional dimension of the blank (1), as a result of which the width of the contact surface equals roughly 0.121-1.124 of said current dimension of the blank (1).

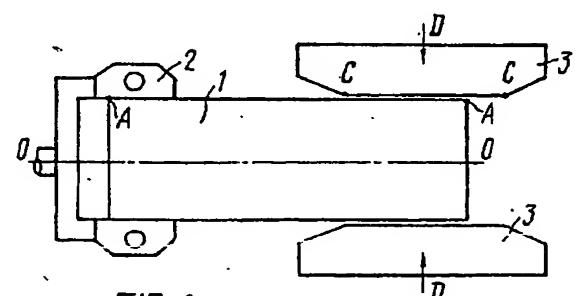

FIG. 1

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of products sizes, as well as wide range of steel grades.

There's known one more method of forging a long hollow blank with the help of a radial-forging machine (see, for instance, an article "Long and continuous forging machines, development and field of application", H.Hojas, Metals Technology, December, 1979). The initial blank of round or polyhedral cross-section is first heated then fed into the interspace of the forging tools without its rotation. The blank is swaged in the interspace of the forging tools, at maximum deformation rate of more than 10%, in turn, first with four forging tools moving simultaneously radially and to blank's axis and then, during the back stroke of the said four forging tools, the blank is swaged, at maximum deformation rate of more than 10%, with the next four forging tools moving simultaneously radially and to blank's axis. When the forging tools accomplish their back travel the blank is moved in the axial direction with the help of rollers. The above mentioned operational cycle is repeated over and over reducing the blank to the required sizes of the final cross-section. However, as a result of radial forging of the initial blank, according to the above described method, a long solid forging is obtained, that is to say, the noted method doesn't make it either possible to produce a hollow forging. From this, there follow all complications related to the subsequent drilling of long solid forging and so on.

According to other method of forging a long solid blank with the help of a radial-swaging machine (see, for instance, an advertisement leaflet of "Andritz" company, Austria, "Hydraulische Schmiedemaschine", Type SMA, Graz-Andritz, Austria. A 017101 2000d-84) the initial blank of round or polyhedral cross-section is heated first, then is set up into the chuck head of manipulator and fed into the interspace of the forging tools being simultaneously rotated. Two forging tools, moving toward each other, swage the blank in radial direction. During the intervals between the swagings, when the forging tools accomplish their back travel, the blank is rotated around its longitudinal axis and moved lengthwise with the help of manipulator. During the next working stroke the forging tools swage other portions of the blank and so on. The above mentioned operational cycle is repeated over and over swaging the blank lengthwise to the required sizes of the final cross-section. The configuration of the forging tools for producing forgings of round cross-section is chosen in the form of radius or V-shaped. However, as a result of radial forging of the initial blank by this method a long solid forging is obtained, that is to say, the considered method doesn't make it either possible to produce a hollow forging.

Thus, none of the existing known methods of radial forging doesn't make it possible to obtain long hollow forgings directly in the process of radial forging of solid blanks.

Description of invention

The goal of this invention is to create a method of obtaining long hollow forgings by radial forging of solid blanks.

This task is solved through the fact that the method of obtaining hollow forgings by radial forging of solid blanks, according to the invention, resides in the following: the generatrix of cylindrical surface of solid blank or the edge of polyhedral solid blank is oriented along the longitudinal axis of the working surface of a forging tool and the blank is swaged in radial direction with the help of at least one pair of forging tools first in one direction, whereupon the blank is rotated around its longitudinal axis and/or moved in the axial direction and then it is swaged in another radial direction at deformation rate set up with every swaging approximately within 3-8% of the current cross-sectional dimension of the blank with the result that the width of the contact surface is approximately within 0.121-0.124 of said current cross-sectional dimension of the blank.

It gives an opportunity to obtain long hollow forgings in the process of radial forging of solid blanks.

It is possible after moving the blank in the axial direction to swage it first and then turn and swage again, and move back in the axial direction.

It ensures obtaining, in the process of radial forging, a chamber in the axial zone of the solid blank only partly lengthwise. It is useful when using a simple and inexpensive manipulator.

If there are several pairs of forging tools creating the working zone, it is expedient to make swagings of the blank with every pair of forging tools alternately.

This technique makes it possible to increase the productivity in the process of accomplishing all the enumerated operations.

It is advisable to make the turning and/or the movement of the blank in its axial direction after alternate swagings with all pairs of forging tools.

This technique relieves manipulator's assemblies of the load created by the torsional moments of force and reduces the rotation speed of its clamping head.

When forging the blanks of materials with high strength, for instance of steel, it is expedient to heat the blank first to the forging temperature between limits 0.65 and 0.80 of the material's melting point on Kelvin scale.

deformation rate when the above mentioned operational cycle is going to be repeated for subsequent expansion of axial chamber 5. The described operations can be done, for instance, only at portion ***M*** (Fig. 4) of blank's 1 length where it is necessary to obtain the axial chamber.

Deformation rate ϵ is assigned within approximately 3-8% of current cross-sectional dimension ***E*** of blank 1. As a result of such swaging the width of the contact area element happens to be within 0.121-0.124 of above mentioned current cross-sectional dimension ***E*** of blank 1. Here, the lower limit of deformation rate $\epsilon_1 = 3\%$ (with the result that width F^1 of contact area element 4 constitutes $\Theta_1 = 0.121E$) stems from the fact, that at lower deformation rate the plastic deformation is localized in surface zone 6 (Fig. 8) of blank 1, it doesn't reach the axial zone where tensile stresses σ do not exceed the elastic limit of blank 1 material.

With deformation rate $\epsilon > 3\%$ the plastic deformation reaches axial zone of blank 1 (Fig. 9), herewith width F^2 of contact area element 4 constitutes $\Theta_2 > 0.121E$ and under this ratio of dimensions in the axial zone of blank 1 there act tensile stresses σ reaching beyond to tensile strength of blank's 1 material and leading to metal's deconsolidation.

The upper limit of deformation rate $\epsilon_3 = 8\%$ (with the result that width F^3 (Fig. 10) of contact area element 4 constitutes $\Theta_3 = 0.124E$) stems from the fact that although the plastic deformation reaches the axial zone, however, under this ratio of dimensions tensile stresses σ do not exist in the axial zone of blank 1 and metal's deconsolidation doesn't take place.

During forging blank 1 when contact area elements of width ***F*** are more then $0.121E$ and less than $0.124E$ tearing the internal layers of blank's 1 material takes place as well as growing the axial chamber with presenting the continuity of the rest part of blank's 1 thickness.

When forging tools 3 (Fig. 11) accomplish their back travel in direction of arrow ***D'*** blank 1 can be moved along axis ***OO*** in direction of arrow ***K*** and then swaged in some other radial direction (along axis ***I–I***, Fig. 3). The mentioned operations are repeated over and over. After having made swagings at portion ***M*** of blank's 1 length, where it is necessary to obtain the axial chamber, the blank is turned around its longitudinal axis ***OO*** in direction of arrow ***G*** and the above mentioned operational cycle is repeated again.

When forging tools 3 accomplish their back travel in direction of arrow ***D'*** (Fig. 4) blank 1 can be turned around its longitudinal axis ***OO*** in direction of arrow ***G*** and moved along axis in direction of arrow ***K*** (Fig. 11) and then swaged in some other radial direction (along axis ***h–h***, Fig. 5, or along axis ***I–I***, Fig. 3).

The mentioned operations are repeated swaging blank 1 around its all periphery.

Initial solid blank 1 can be a polyhedron in its cross-section, for instance, a square (Fig. 12).

In this case edge B_1B_1 (Fig. 12) of polyhedral blank 1 is oriented along longitudinal axis ***CC*** of the working surface of forging tool 3 and swaged in radial direction with a pair of forging tools 3 in direction of arrow ***D*** at deformation rate ϵ of current cross-sectional dimension ***E*** of blank 1. As a result of swaging there on blank 1 (Fig. 14) appear contact area elements 4 with width F_1, constituting value Θ $(0.121<\Theta<0.124)$ of above mentioned current cross-sectional dimension ***E*** of blank 1 (Fig. 13).

When forging tools 3 accomplish their back travel in direction of arrow ***D'*** (Fig. 14) blank 1 can be turned around its longitudinal axis ***OO*** in direction of arrow ***G*** and oriented by its adjacent edge B_2B_2 unswaged during the preceding stroke of forging tools (Fig. 12 and Fig. 14), along longitudinal axis ***CC*** of the working surface of forging tool 3 and then swaged in some other radial direction (along axis ***I–I***, see Fig. 12) at deformation rate ϵ with the result that there on blank 1 appear new contact area elements with width F_2, constituting value Θ $(0.121<\Theta<0.124)$ of cross-section dimension ***E*** of blank 1. As this take place, there in the axial zone of blank 1 starts opening chamber 5 (for the case of polyhedral blank the chamber is not illustrated).

The above mentioned operational cycle is repeated over and over swaging blank 1 around its all periphery with the result that its cross-section acquires dimension ***E'*** and axial chamber 5 correspondingly dimension ***J'***.

Although the claimed method is described by the example of forging a blank of square cross-section it is obvious that the same sequence of operations is used in forging initial blanks of cross-section with more edges and the same result of obtaining an axial chamber in a blank is achieved.

When forging tools 3 accomplish their back travel in direction of arrow ***D'*** blank 1 can be moved along axis ***OO*** in direction of arrow ***K*** (Fig. 11) and then swaged in some other radial direction (along axis ***I–I***, Fig. 12). The above mentioned operational cycle is repeated over and over.

After having made swagings at portion ***M*** (Fig. 11) of blank's 1 length, where it is necessary to obtain the axial chamber, the blank can be turned around its longitudinal axis ***OO*** in direction of arrow ***G*** and oriented by its adjacent edge B_2B_2, unswaged during the preceding forging pass, (Fig. 12 and Fig. 13) along longitudinal axis ***CC*** of the working surface of forging tool 3 (Fig. 14) and the indicated operational cycle can be repeated again.

obtained with final size of cross-section in 72.8 mm (measured between two opposite flat parts of the cross-section). The continuity of blank's material in the axial zone was preserved, that is, there were no holes.

Thus, the claimed method of obtaining hollow forgings by radial forging of solid blanks makes it possible to obtain long hollow forgings only at deformation rate 8%>ϵ>3% and, as a result, the width of the contact area element is within 0.121-0.124 of the current cross-sectional dimension of the blank. Therewith it is possible for the first time to obtain an axial channel both along blank's full length and along some part of it, as well as a blind axial chamber without outlets to either end of the forging.

The usage of the claimed method of obtaining hollow forgings by radial forging of solid blanks makes it possible to eliminate deep drilling of forgings that is used nowadays in production of long hollow products. As a result of that there is no need to have additional shop of precision machine tools and keep skilled labor. Besides, the utilization of the claimed method makes it possible to save up to 60-80% of metal wasted into chips by eliminating the time-consuming process of deep drilling.

Industrial applicability

The claimed method of obtaining hollow forgings guarantees a substantial expansion of assortment of products obtained by radial-forging.

It is quite obvious that obtaining hollow forgings by radial forging of solid blanks is cheaper than using intermediate hollow blanks received, for instance, by rolling and piercing.

In addition to the increase in production rate the new method in comparison with machining (deep drilling of solid intermediate blanks) has another advantage, namely, high quality deformation of the cast metal structure through the forging's wall. As a result, it improves substantially the mechanical properties of products. For instance, it is possible to reach approximate parity of values for metal toughness in longitudinal and transversal directions of the product what is impossible to do with the help of other known methods: neither by drilling solid forgings, nor by mandrel-forging of previously drilled blanks.

Claims

1. Method of obtaining hollow forgings by radial forging of solid blanks distinguished by the fact that generatrix (AA) of the surface of cylindrical solid blank (1) or edge (BB) of polyhedral solid blank (1) it oriented along longitudinal axis (CC) of the working surface of forging tools (3) and blank (1) is swaged in radial direction (D) by at least one pair of forging tools (3) first in one direction, whereupon it is turned around longitudinal axis (OO) and/or is moved in axial direction, and then is swaged in another radial direction, as this takes place deformation rate (ϵ) is fixed for every swaging within 3-8% of the current cross-sectional dimension (E) of blank (1) with the result that width (F) of contact area element (4) is approximately within 0.121-0.124 of said current cross-sectional dimension (E) of blank (1).

2. Method distinguished from claim 1 by the fact that after having had been moved in the axial direction blank (1) is swaged first, then turned, then again swaged and moved in back axial direction.

3. Method distinguished from claims 1 and 2 by the fact that if there are several pairs of forging tools (3) the swaging of blank (1) is performed, in turn, by every pair of forging tools (3).

4. Method distinguished from claims 1 and 3 by the fact that the turning of blank (1) and/or its movement in axial direction is done after alternate swaging by all pairs of forging tools (3).

5. Method distinguished from claims 1,2,3 and 4 by the fact that blank (1) is heated first to forging temperature being in the range of approximately 0.65-0.80 of the melting point for blank's (1) material on Kelvin scale.

6. Method distinguished from claim 5 by the fact that the surface of hot blank (1) is cooled to the temperature being in the range of approximately 0.50-0.55 of the melting point for blank's (1) material on Kelvin scale.

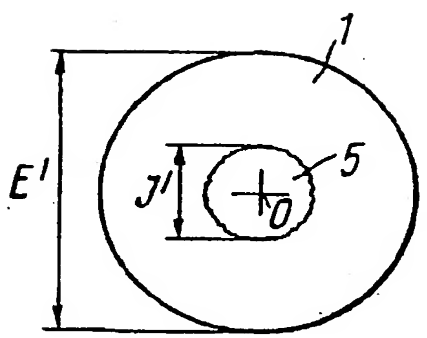

FIG. 7

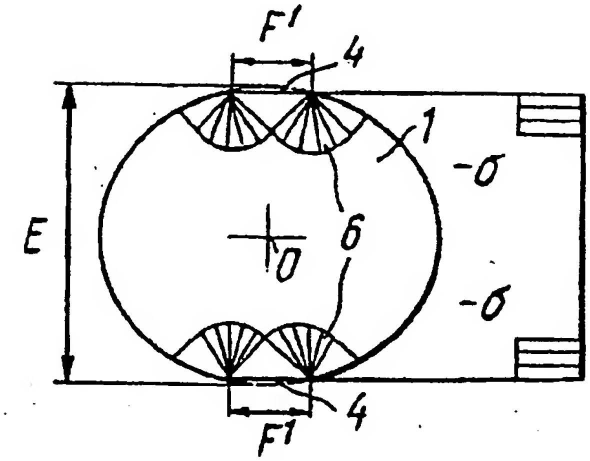

FIG. 8

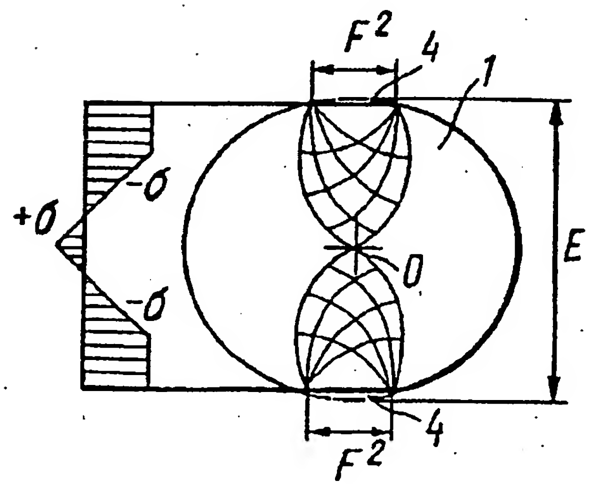

FIG. 9

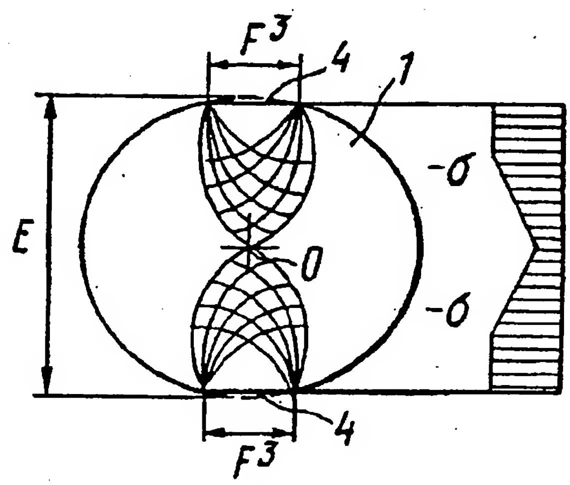

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU93/00124

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl.5 B21J 5/00; B21K 21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl.5 B21J 1/04, 5/00, 7/14, 7/16; B21K 21/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU, A, 715195 (ERMAKOV V.V. et al.) 15 February 1980 (15.02.80) ---	1-6
A	SU, A1, 1634355 (URALSKY POLITEKHNICHESKY INSTITUT IM.S.M. KIROVA) 15 March 1991 (15.03.91) ---	1-6
A	DZUGUTOV M.YA."NAPRYAZHENIYA I RAZRYVY PRI ABRABOTKE METALLOV DAVLENIEM" 1974 METALLURGIYA, (MOSCOW), pages 165-171 --------	1-6

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Date of the actual completion of the international search	Date of mailing of the international search report
29 July 1993 (29.07.93)	22 September 1993 (22.09.93)
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